2010 Awards

Subhadeep Gupta
University of Washington, Seattle, Washington
Measurement of the fine structure constant and test of QED at the sub-ppb level

The research supported by this grant is to measure the fine-structure constant and test quantum electrodynamics (QED) at the sub-part per billion (ppb) level. Using a contrast atom interferometry technique with ytterbium Bose-Einstein condensates (BEC), the PI proposes to perform a measurement of the fine-structure constant α with a relative uncertainty better than a part-per-billion, and thus test QED at this unprecedented level. The best value for α at 0.37 ppb comes from a recent measurement of the electron magnetic moment and an involved QED calculation of its relation to α. The PI proposes to apply an extension of a contrast interferometry technique to ytterbium Bose-Einstein condensates for a sub-ppb value of α. Comparisons of this atom interferometry based theory-free measurement of α against the QED involved route to α would thus form the most stringent test of the fundamental theory of quantum electrodynamics.

Carol Tanner
University of Notre Dame
A portable optical atomic clock in neutral silver

The research supported by this grant is to measure transition frequencies in neutral silver to an accuracy that is several orders of magnitude better than the currently known values. This of interest, because the neutral silver atom is an excellent candidate for a portable optical clock. Commercial beam-based Cs clocks have an accuracy of parts in 10^{12} giving picosecond-timing resolution in one second. The world's best time standards use an atomic fountain to reach an accuracy of parts in 10^{15} when averaged over one day. Unfortunately, the long averaging time makes it difficult to take advantage of this accuracy in real time. A clock based on an optical transition with an oscillation frequency near 10^{15} Hz, as in the silver atom, can achieve femtosecond-timing resolution in one second, making it possible to improve on various real-time applications, such as the Global Positioning System, distance ranging, and broad-band communication, as well as fundamental investigations such as mapping gravity, testing general relativity, and measuring the time variation of fundamental constants.